Measuring N_2O Emissions in California: A Collaborative Multi-agency Study

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STATE OF CALIFORNIA resources AGENCY

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Multiagency effort to address GHG emission from agriculture

CA.GOV California Environmental Protection Agency AIR RESOURCES BOARD

CA.GOV CALIFORNIA DEPARTMENT OF Food and Agriculture

The California ENERGY COMMISSION

Driver:

CALIFORNIA GLOBAL WARMING SOLUTIONS ACT OF 2006

In this talk

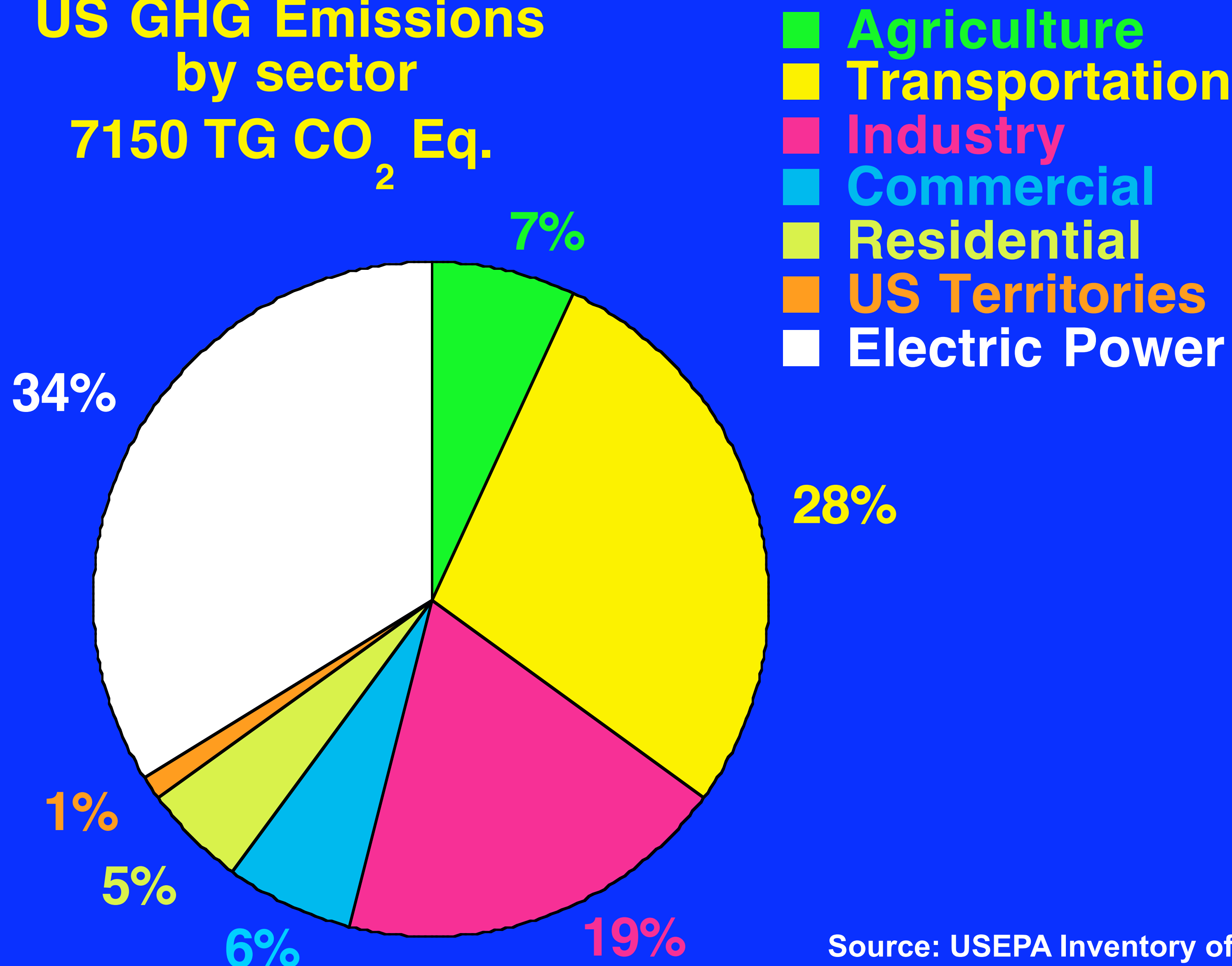
- **Research Objectives**
- **Agricultural GHG emissions overview**
  - **N_2O and CH_4**
- **Over on GHG processes**
- **Methodology**
- **Results (preliminary)**
- **Perspective**

Research Objectives

- **Estimate annual baseline N_2O emissions in representative cropping systems**
- **Determine reductions in N_2O emissions through lower N inputs, without yield penalty**
- **Determine N_2O emission factors in response to a range of N fertilizer inputs**
- **Identify key environmental (magnitude of influence) conditions affecting N_2O flux**
- **Provide data for modeling by collaborators**

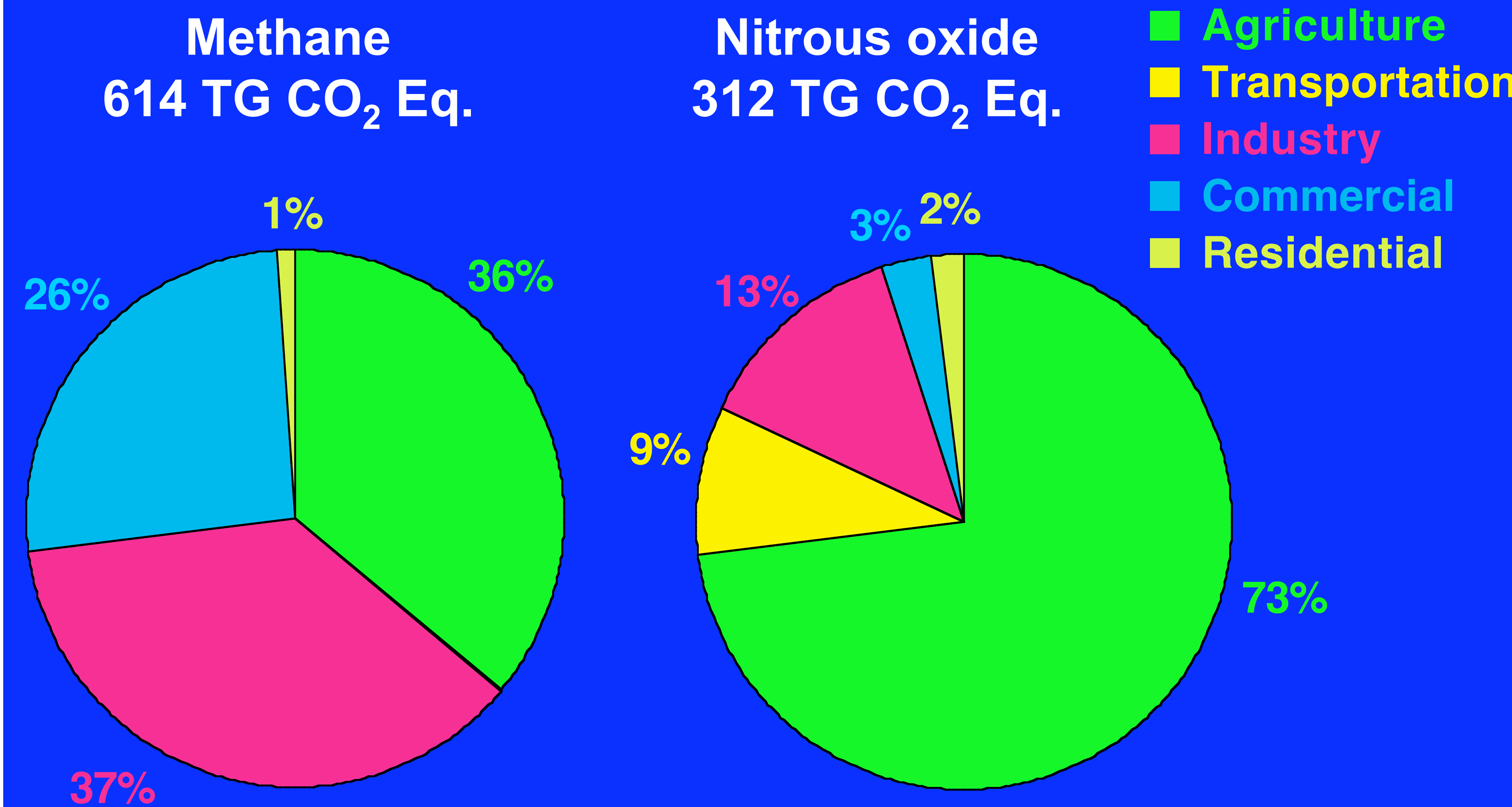
GHG emission overview

US GHG Emissions by sector
7150 TG CO_2 Eq.



Source: USEPA Inventory of US GHG Emissions, 2007

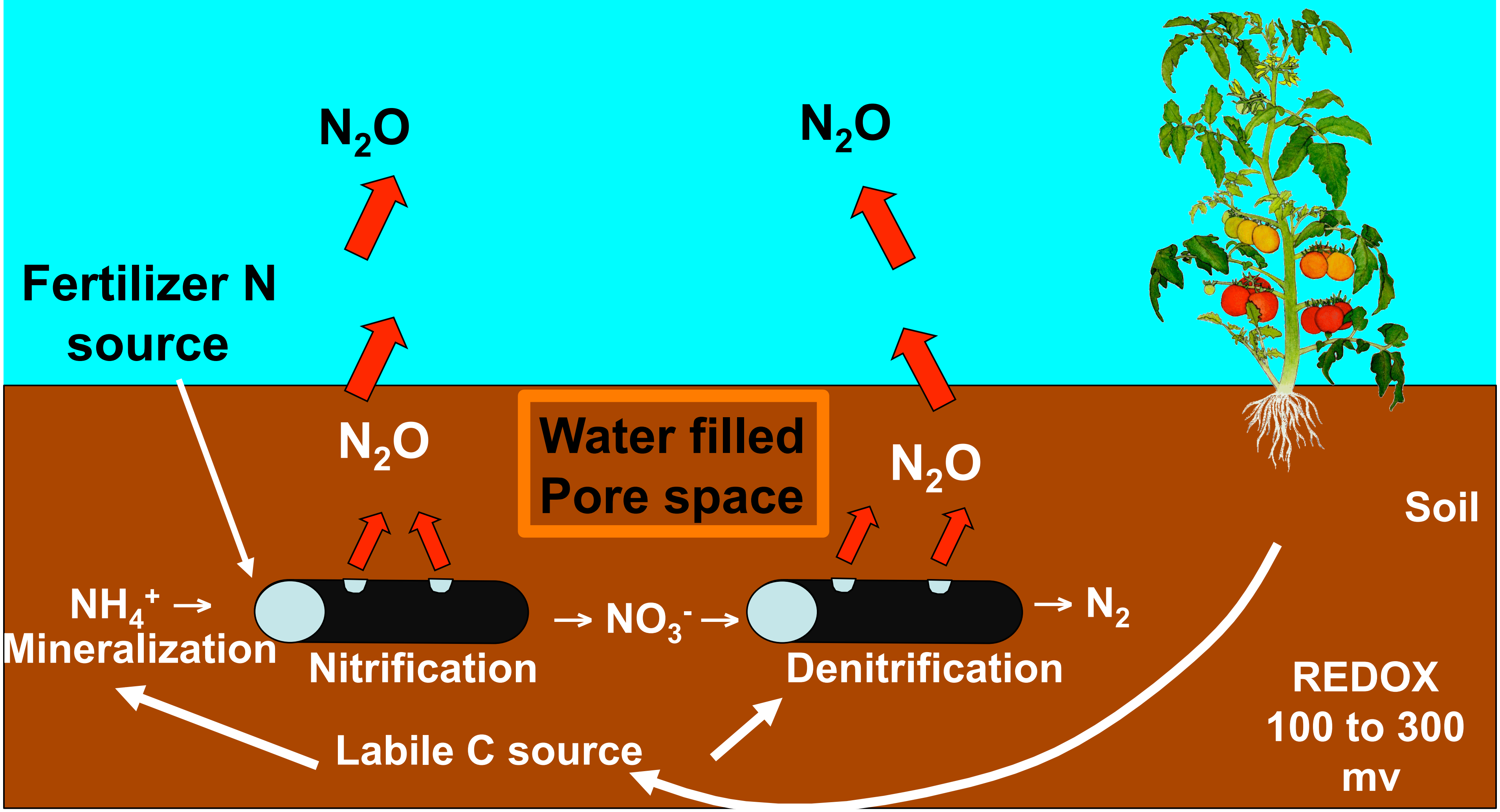
US emissions of methane and nitrous oxide

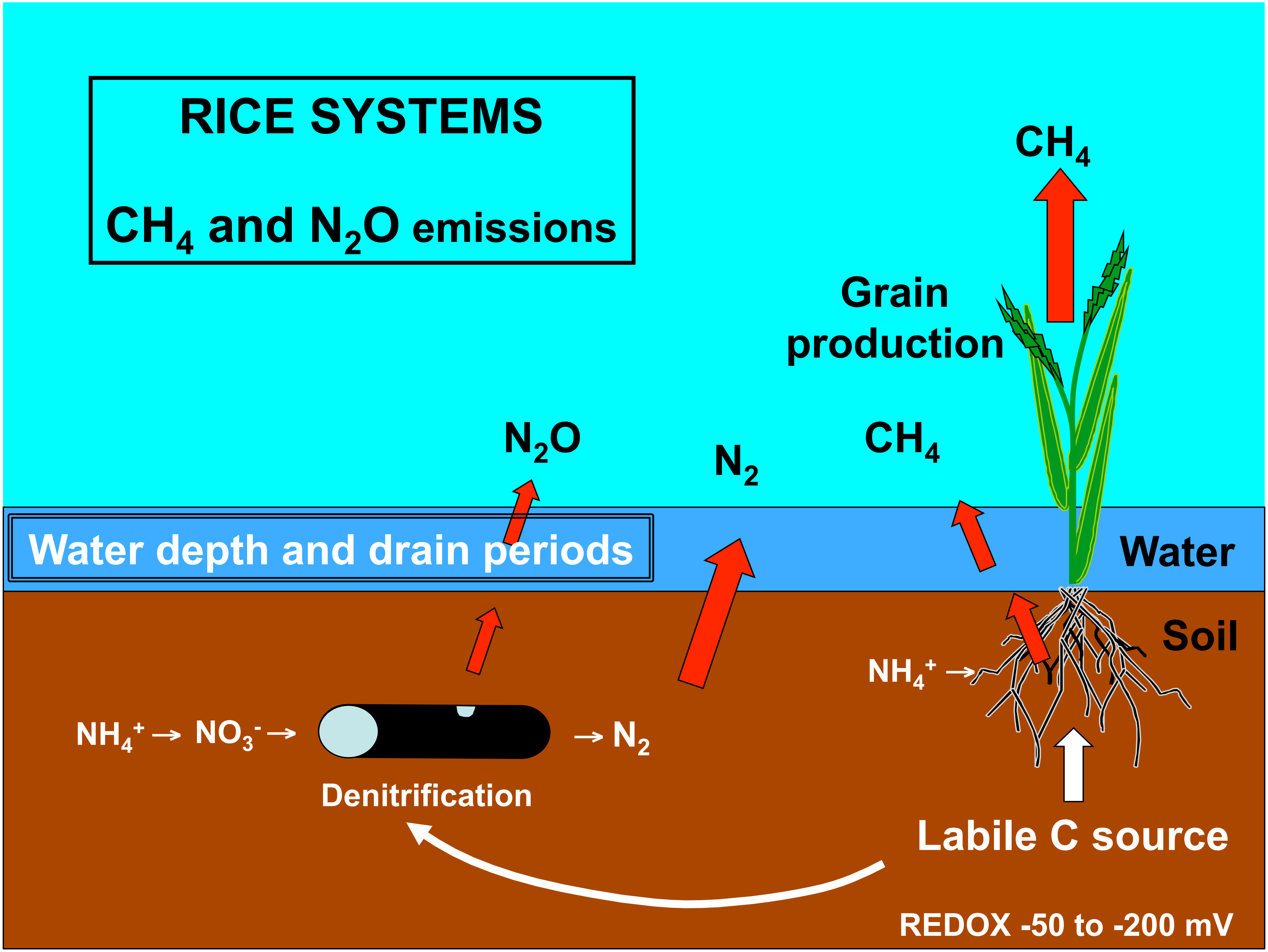


Source: USEPA Inventory of US GHG Emissions, 2007

N_2O production and emission from soil

The "Leaky Pipe Theory"





RICE SYSTEMS
CH_4 and N_2O emissions
CH_4
Grain production
N_2O
N_2
CH_4
Water depth and drain periods
Water
Soil
NH_4^+ →
$NH_4^+ \rightarrow NO_3^- \rightarrow$
$\rightarrow N_2$
Denitrification
Labile C source
REDOX -50 to -200 mV

Chambers used for static N_2O flux measurements in the field

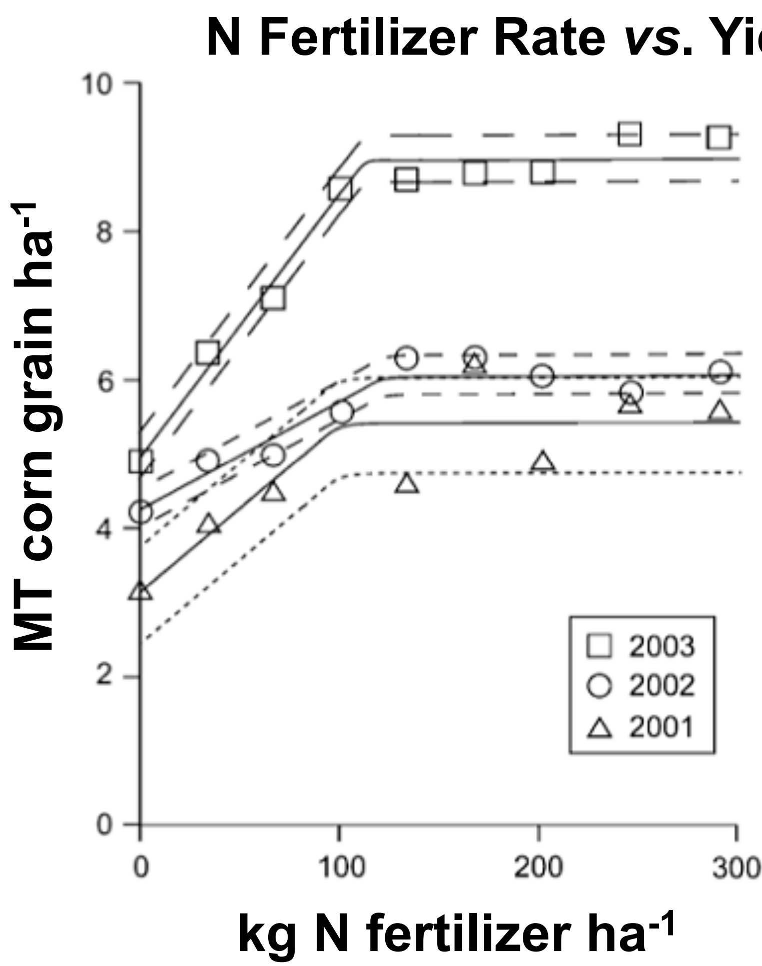
Annual N_2O Emission Measurements

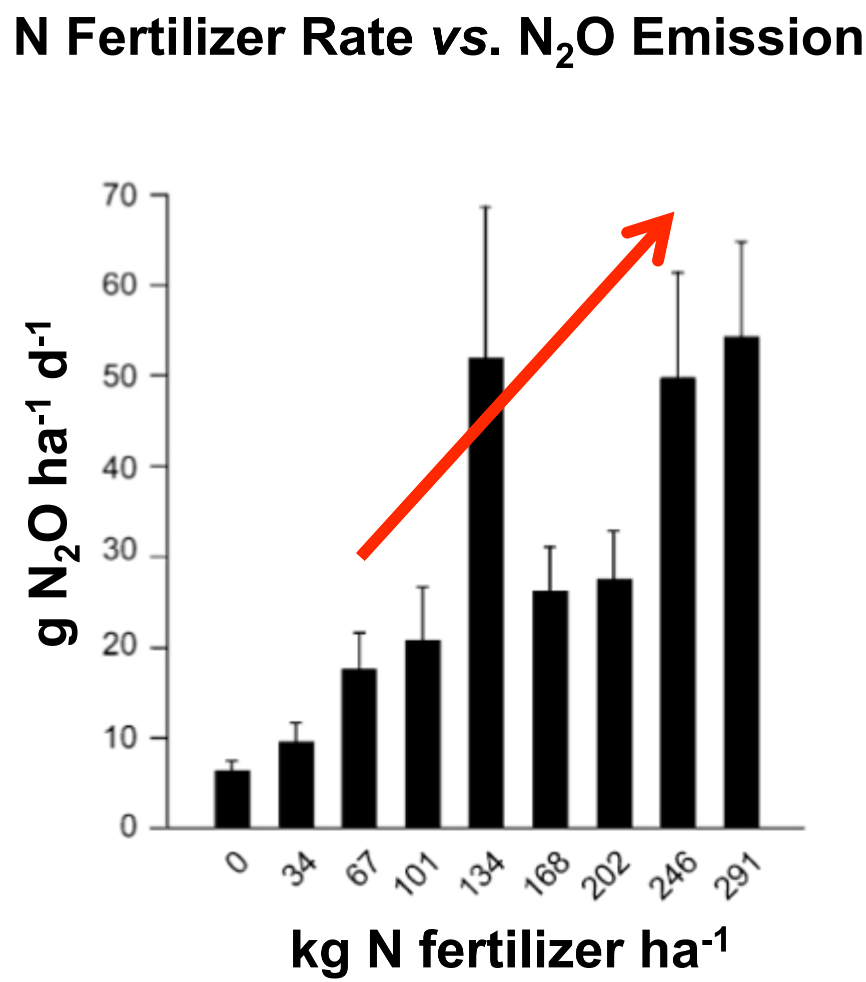
- Year-round N_2O flux measurements
- Frequent event-based N_2O flux measurements
  - after N fertilization
  - following irrigation and rainfall events
  - incorporation of residue
- Integrate flux measurements to estimate yearly N_2O emissions

Baseline N_2O and CH_4 Emissions Selected Crops

	Acreage	Inputs kg N/ac	Region
Alfalfa	1050,000	0-25	SV
Wheat, oats, barley	730,000	0-90	SV
Rice	526,000	0-200	SV
Lettuce, broccoli, celery	360,000	50-150	Coastal
Tomato	324,000	50-120	SV
Almonds, walnuts	800,000	20-160	SV
Vineyards	790,000	0-50	SV
Cotton	560,000	30-120	SJV
Corn	520,000	0-140	SJV

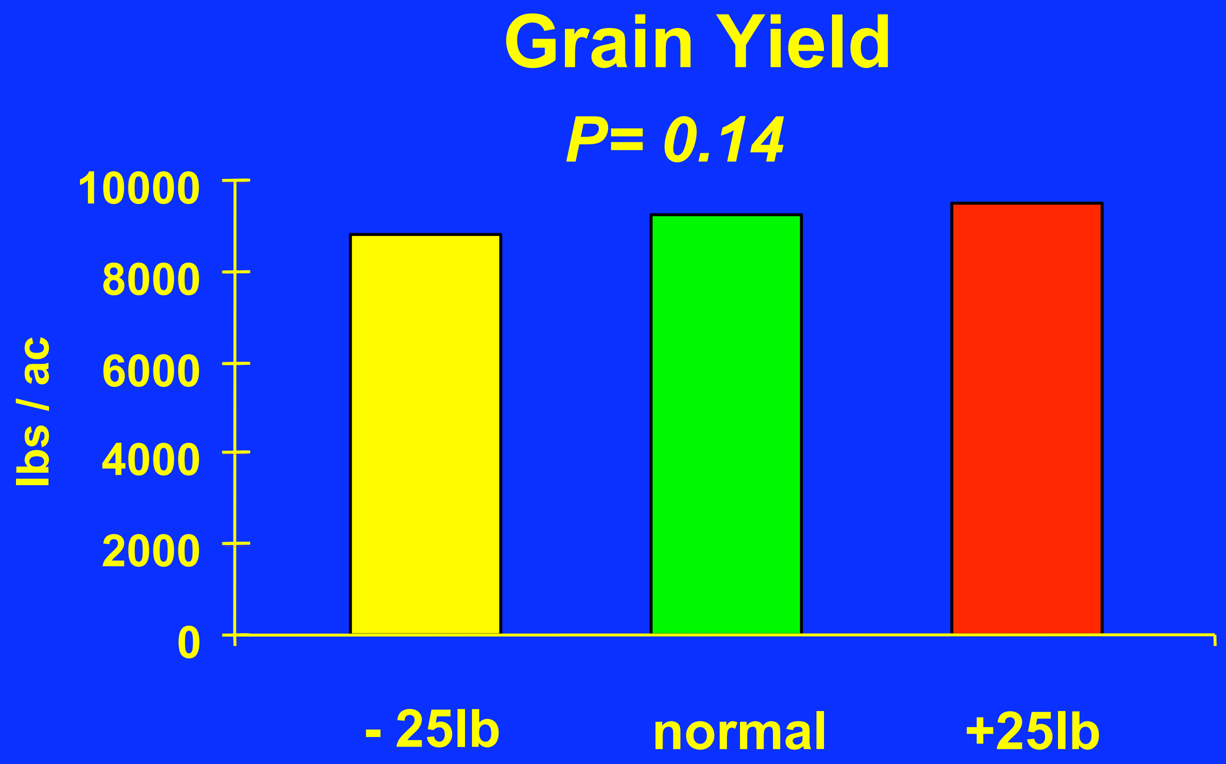
N_2O emissions, Yield and Fertilizer N in corn



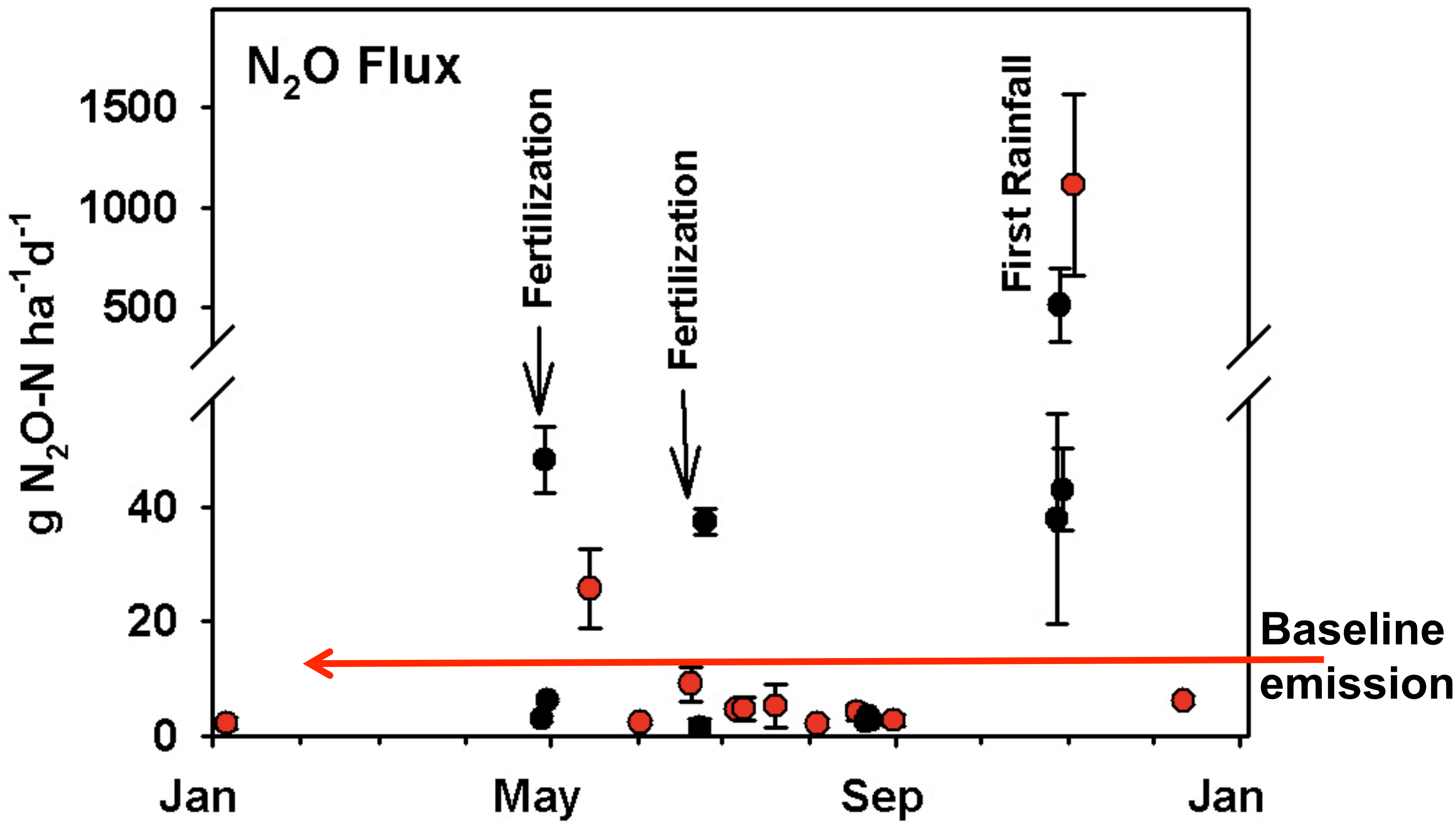


McSwiney & Robertson, 2005

Rice yields as influenced by over and under recommendations of fertilizer N per acre

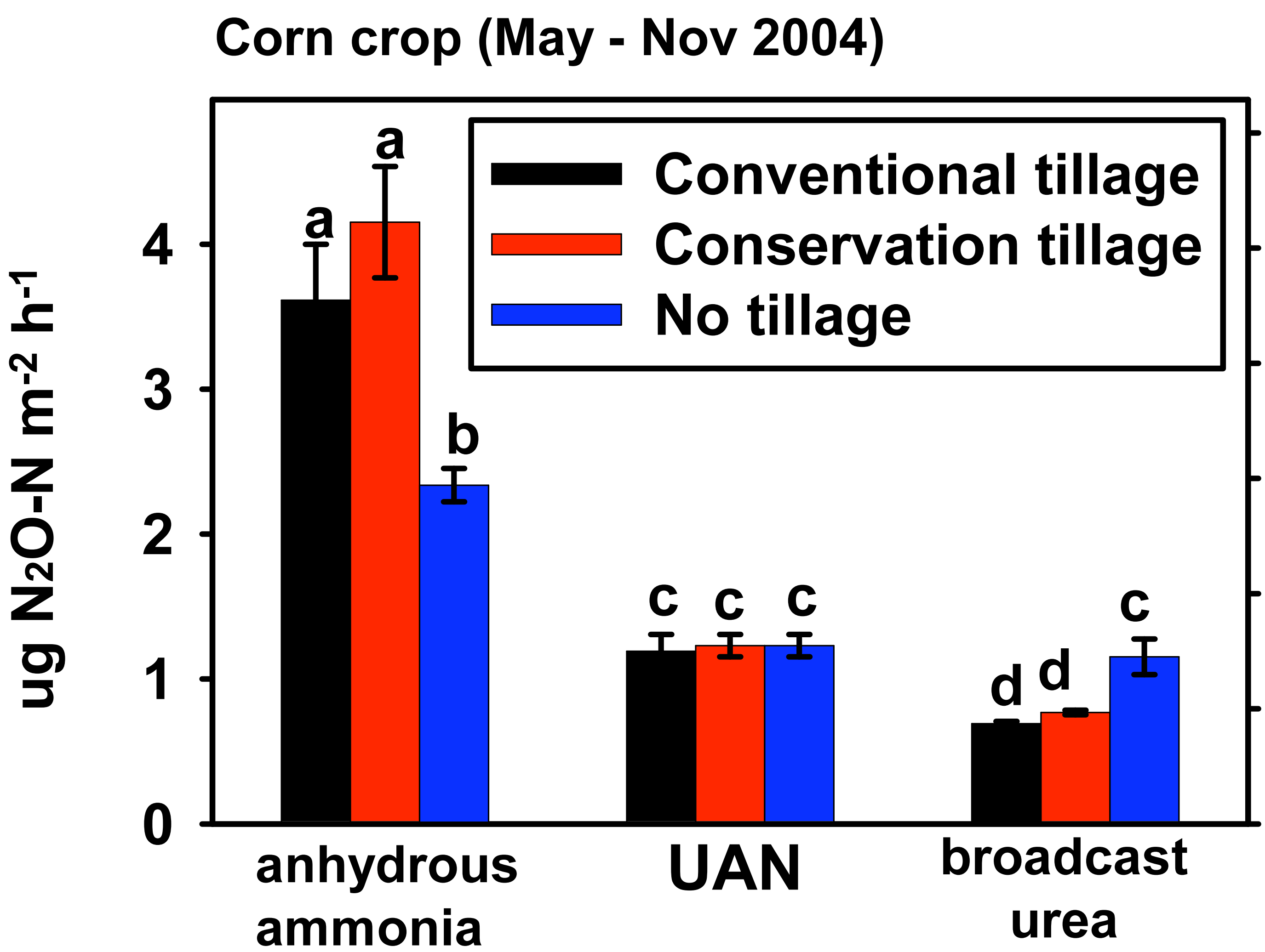


N_2O emissions tend to be event based

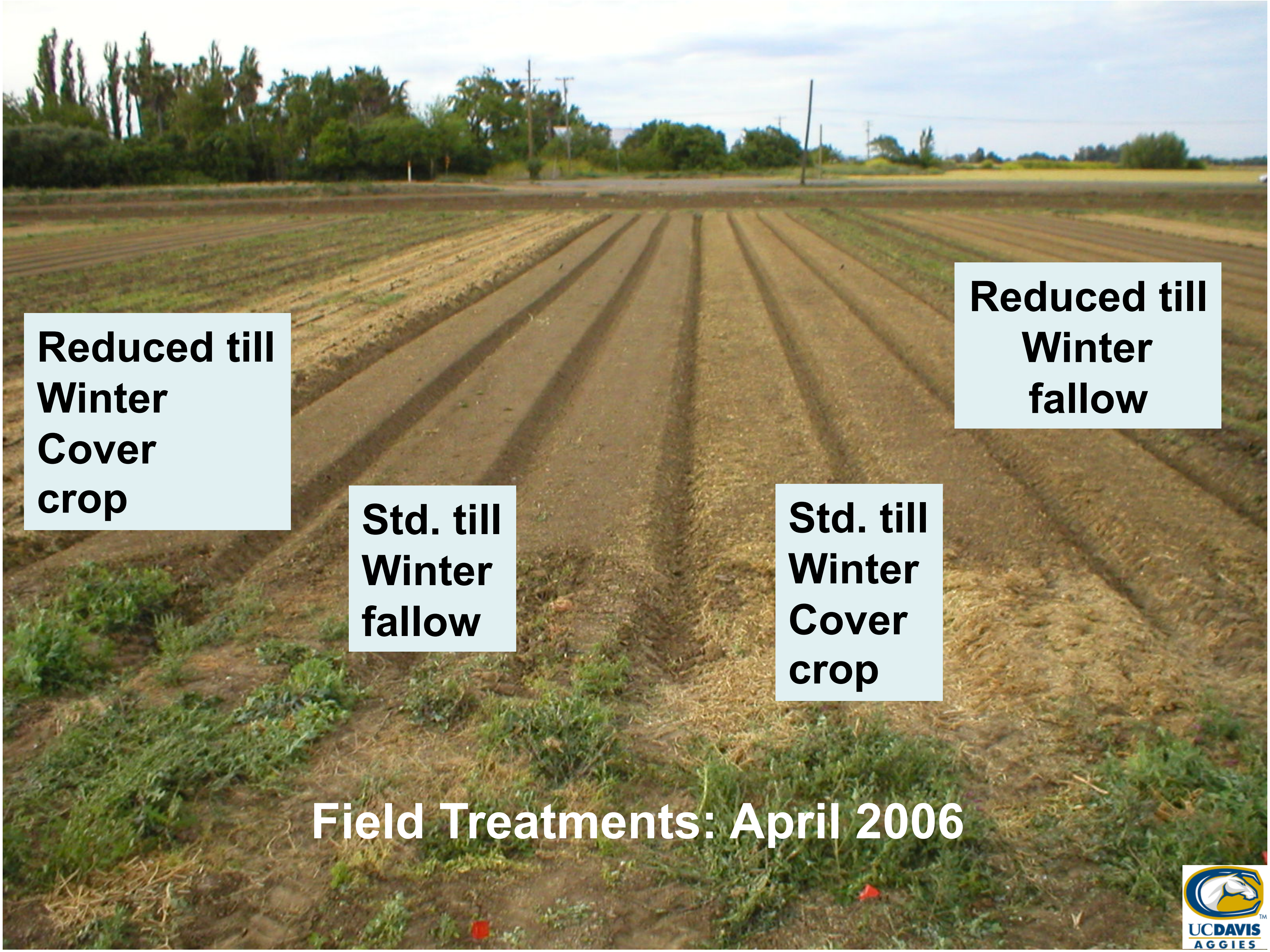


Kallenbach, 2008; Burger et al., 2005

Interaction of Fertilizer Type & Tillage on N_2O Emissions

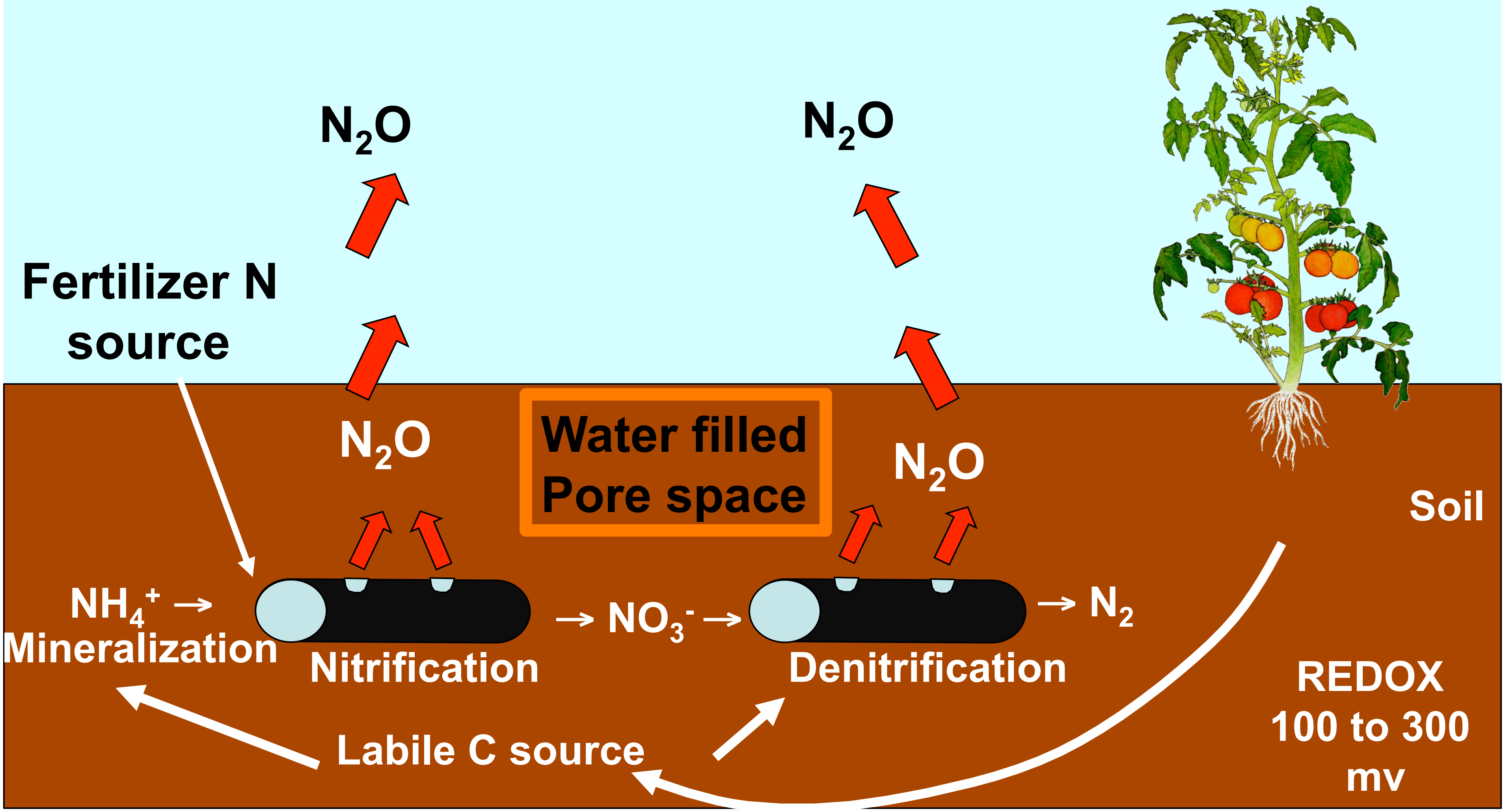


Venterea et al., 2005

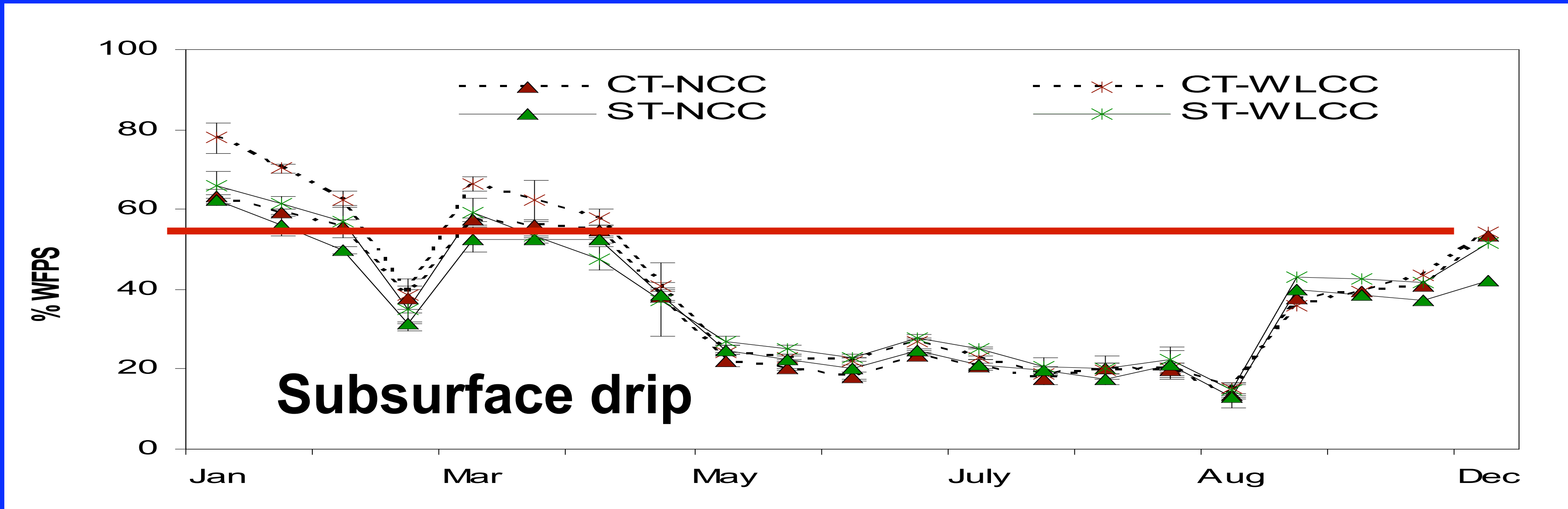

Reduced till Winter Cover crop
Std. till Winter fallow
Std. till Winter Cover crop
Reduced till Winter fallow
Field Treatments: April 2006
UC DAVIS AGGIES

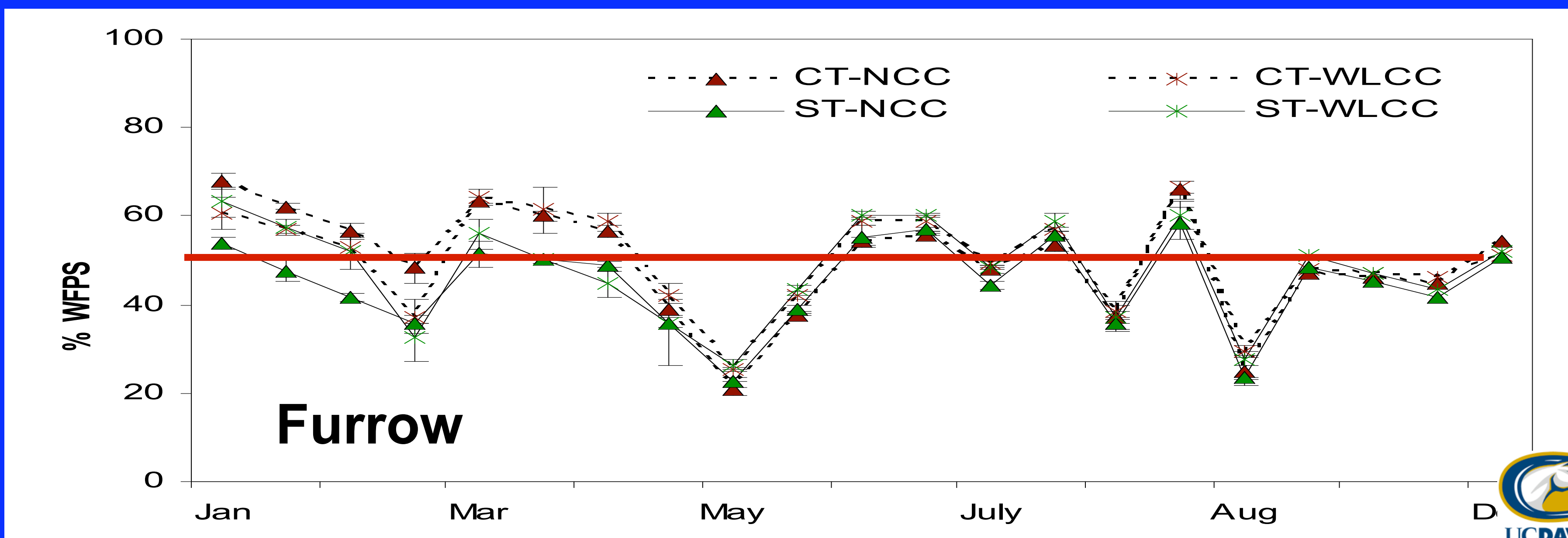
N_2O production and emission from soil

The "Leaky Pipe Theory"

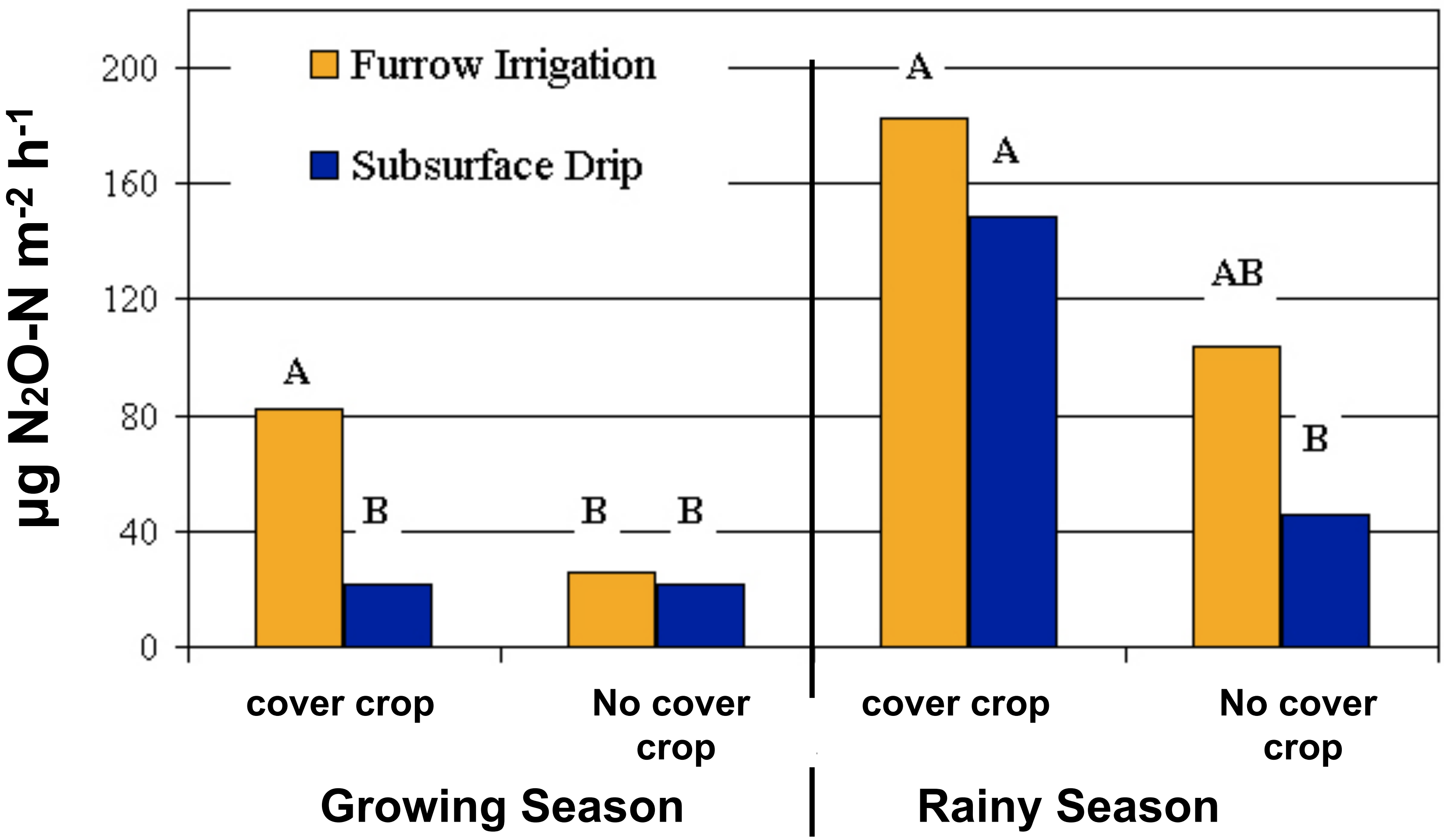


Water filled pore space/irrigation comparison



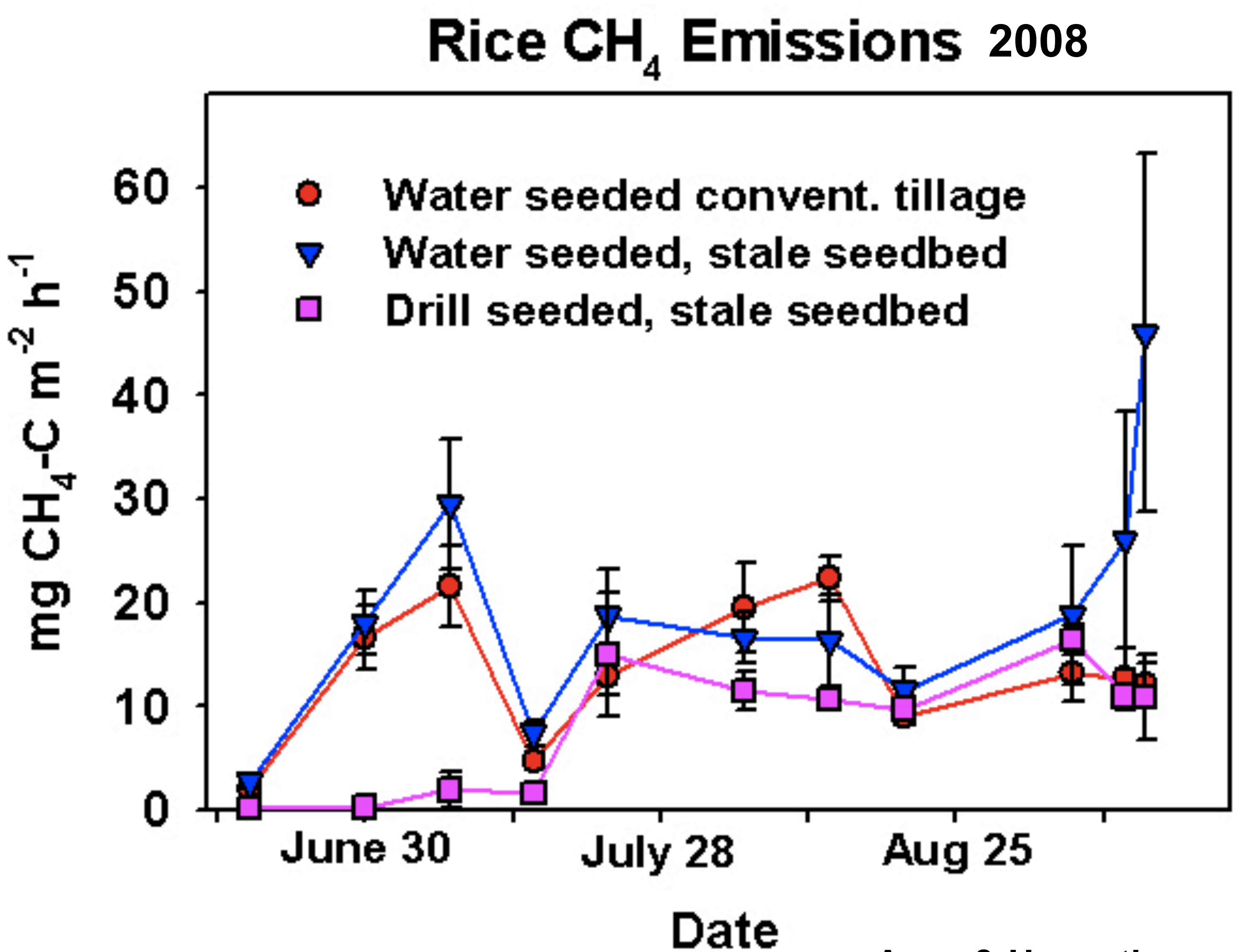


Irrigation and Cover Crop Effects on N_2O Emissions



Kallenbach, 2008

Methane Emissions Rice
Rice Experiment Station, Biggs, CA



Assa & Horwath, unpublished data

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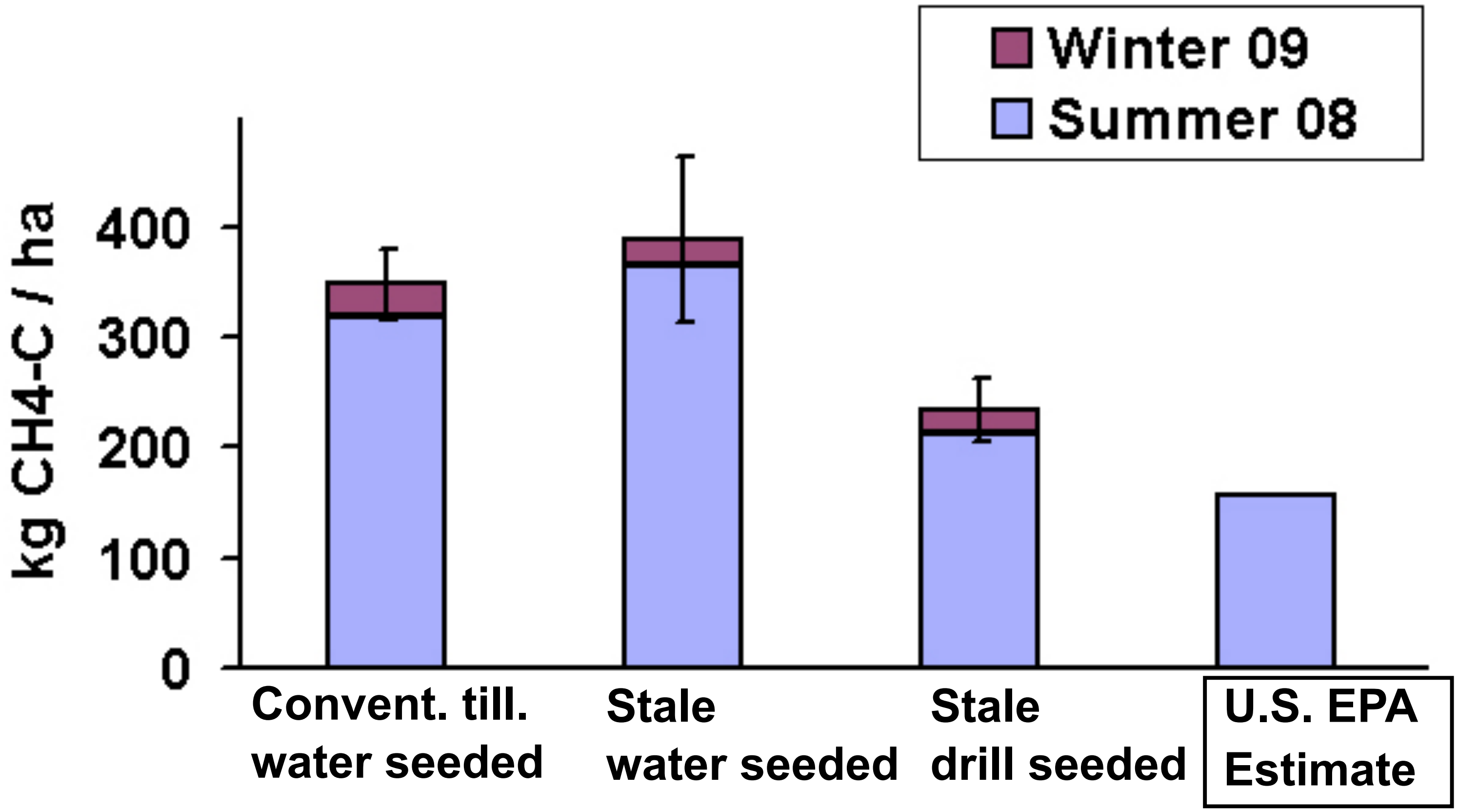

Assa & Horwath, unpublished data

Benefits of N_2O Multiagency Monitoring Project

- Baseline N_2O emissions for 10 types of cropping systems occupying 5 million acres of CA agricultural land
- N_2O emission factors at multiple N fertilizer levels to estimate potential N_2O emission offsets at reduced N fertilizer levels (Sliding emission factor)
- Minimum data set to calibrate and validate models
- Use results to evaluate effects of alternative management practices and future changes in California's cropping systems on N_2O emissions

Conclusions

- Controls and drivers of N_2O emissions are well known, but the interaction of factors affecting emission and magnitude of the emissions are difficult to predict
- Optimizing N fertilizer use efficiency is the best strategy to minimize N_2O emissions
  - Sounds easy!!
- N_2O flux measurements in California cropping systems will provide improved emission estimates and information on mitigation potential